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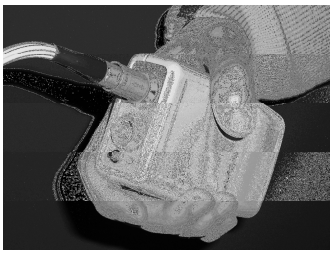
Appendices

Appendix I: VU-AMS.5fs

The Vrije Universiteit Ambulatory Monitoring System, or VU-AMS for short, is a system for measuring bio-signals during normal daily activities, in real-life settings. The complete VU-AMS consists of:

- AMS device, a small lightweight device for the actual ambulatory recording
- AMS*i* interface cable to connect the VU-AMS device to your PC via a USB or RS232 connection
- AMS software



The VU-AMS.5fs is the most recent version of the VU-AMS. The VU-AMS.5fs measures the electrocardiogram (ECG), the thorax impedance (Z0), the changes in thorax impedance (dZ), the impedance cardiogram (ICG), the skin conductance level (SCL), phonocardiogram (PCG) and the vertical and horizontal acceleration of the subject (body movement).

The main features of the VU-AMS.5fs device are:

- Full ECG signal recording at a maximum sampling rate of 1000Hz with a 16-bit resolution. The ECG signal is used to extract the interbeat interval time series.
- Full recording of thorax impedance (dZ) at 1000Hz (16 bit). From the dZ signal the ICG (dZ/dt) is calculated offline and used to extract systolic time intervals.
- Full recording of skin conductance in DC or AC (10Hz) mode (16 bit) from which skin conductance level or skin conductance responses can be computed.
- Recording of vertical and horizontal acceleration to index gross body movement of the subject.
- Optional: Full recording of heart sound (PCG) at a maximum sampling rate of 1000Hz (16 bits).
- All signals (ECG, ICG, skin conductance, motility, heart sounds) are recorded simultaneously from a single device.
- Data is stored on Compact Flash memory cards. Storage capacities of 1 gigabyte (and higher) make it possible to record all raw signals at their highest sampling rates for at least 24 hours, and up to 72 hours at typical sampling rates.
- The VU-AMS.5fs uses two standard AA-type batteries. This makes it possible to use high capacity rechargeable NiMh batteries. Recordings of up-to 48 hours are possible when using 2600mAh types, without changing batteries. Longer recordings are possible with additional batteries. The memory cards allow repeated replacement of the batteries without any data loss.
- An infrared interface cable connects the VU-AMS device to the PC for online monitoring (serial RS232 or USB ports).

Changes from the older 4.6 version

The new 5fs version stores the complete ECG/dZ signals allowing a higher sampling frequency (form 250 to 1000 Hz) and increased sampling resolution (16-bit). In combination with improved filtering techniques this increases the signal-to-noise ratio and allows greatly improved offline analysis and artifact correction strategies. Batteries can now be changed without data loss.

For **backward compatibility**, a special data conversion program is available to convert the new data files back to the old 4.6 file format. This makes it possible to use the original VU-AMS analysis software package (AMSGRA, AMSRES, AMSIMP) to label data and (interactively) score parameters like heart rate, pre-ejection period and respiratory sinus arrhythmia.

Appendix II: User Manual

Ambulatory monitoring with the VU-AMS version 5fs

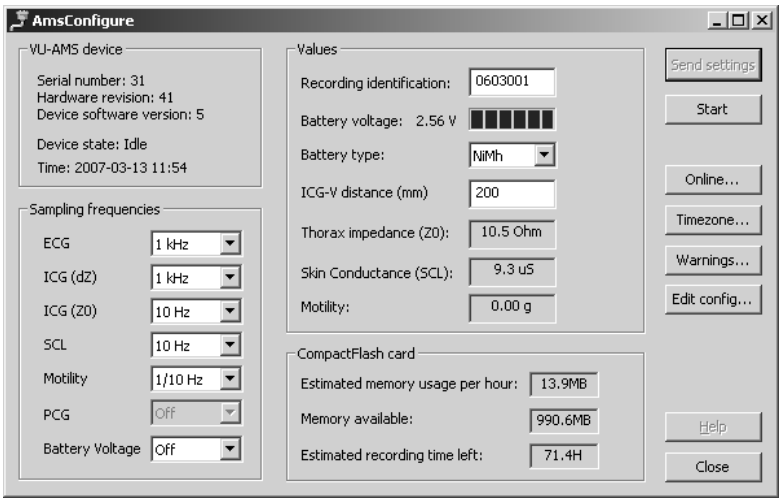
Requirements
Two AA batteries: Use 1.2V rechargeable NiMh batteries or non-rechargeable 1.5V alkaline batteries.
Compact flash card: External memory card. The VU-AMS.5fs has been extensively tested with the 1GB 80x Compact Flash card from Transcend (TS1GCF80). Other flash cards may work too.
Compact flash card reader: Card reader unit to extract the AMS data from the flash card after recording and to erase the card for a next recording. Any brand or built-in flash card reader will do.
Electrodes: Seven electrodes are needed for a single recording. We use the 'UltraTrace®' single use clear tape ECG electrode with Wet Gel.
Lead wire connector: A blue lead wire connector with 7 lead wires is used for the recording of the ECG and thorax impedance. Optionally a second yellow connector with two lead wires for skin conductance recording is needed.
VU-AMS.5fs: The ambulatory recording device.
VU-AMS*i* (with optional RS232-to-USB converter): An infrared interface cable that either connects to the RS232 serial port of a PC directly or through an RS232-to-USB converter.

Signal recording
Use an empty Flash Card for each new measurement. First, put the flash card bottom up in the VU-AMS and then place two completely charged AA batteries in the battery holder. Successful placement is signaled by a beep tone and a green light. When the VU-AMS has started, you will hear a triple beep tone. After you close the battery lid, the VU-AMS is ready for use. The green light will flash twice every ten seconds. This indicates the VU-AMS is ready, but *not* recording.

Connect the VU-AMS to the PC with the interface cable (marked: AMS*i*). Connect the infrared end of the interface cable to the VU-AMS; the electronic end of the interface cable goes to the serial port of the PC (or to the serial-to-USB converter).

Now start the AmsConfigure program. It tries to automatically detect the VU-AMS device on all available COM ports. If successful, the opening screen (see figure below) will be displayed. Check the battery type, battery voltage indication (should be about 3 Volt for alkaline and about 2.6 Volt for rechargeable NiMh batteries), and re-check time and date. Fill out the identification field. *NB:* If you intend to use our preprogrammed SPSS scripts, make sure the identifier is exactly 7 characters long. Try to use a numerical name only (e.g. 0603001).

NOTE: Before you start AmsConfigure, make sure to set date and time of the PC correctly. All dates and times in the AMS data files will be based on the time and date read from the PC at start-up, so it is important to make sure your PC has the correct time and date. The VU-AMS will verify time and date of the PC against its internal Real Time clock; deviations > 5 minutes (configurable in 'Warnings') will be flagged by AmsConfigure.



The typical sampling frequencies are as shown in the figure. AmsConfigure allows you to set sampling frequencies for the various signals. You can also disable signals here by setting them to 'Off'. When you change the settings, **make sure to send the settings to the device before closing the screen!**

Attach the electrodes as explained in the instruction leaflet "How to attach the VU-AMS.5fs" (Appendix III). This instruction leaflet is used by our subjects to (re)attach the device themselves (for instance after taking a shower).

After connecting the ECG/ICG lead wire plug the 'Online' option of the AmsConfigure program can be used to display the ECG, Z0, dZ and ICG. The dZ should be within -0.5 and +0.5 Ohm most of the time. Z0 should always stay within an 8 to 20 Ohm range. The dZ signal should reflect deep breathing clearly. In the ICG the typical waveform of the cardiac ejection phase should be clearly detectable. Light movement of the subject should not overly distort it. If these criteria are not met, re-attach the electrodes in the order 7,6,1,3,4,5,2 until satisfactory signals are obtained.

NOTE: In ambulatory paradigms, this is your only opportunity to re-attach faulty electrodes.

When satisfied, start data recording by pressing the 'start' button. A beep will be heard to acknowledge the start of the recording and the green light will start flashing once every three seconds. You may now disconnect the VU-AMS device from the interface.

Synchronize the watch of the subject to the exact time of your VU-AMS for optimally time-locked self-report diary and physiological data.

At the end of the recording the measurement is stopped by pressing the event button for three seconds. You may now disconnect the lead wire plug(s) from the connector(s) and the lead wires from the electrodes. The subjects can also do this themselves at home at a designated time.

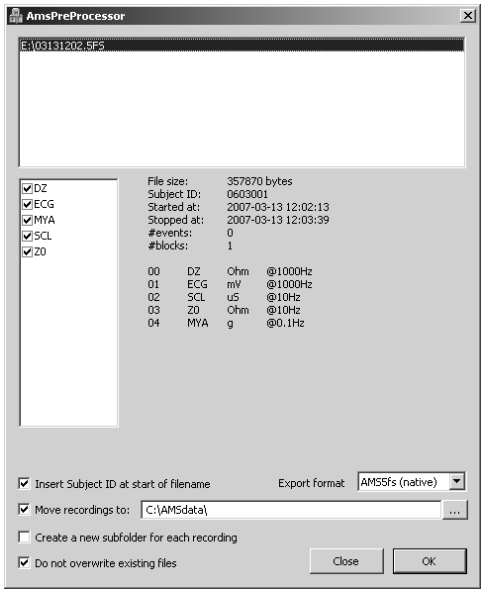
Once the device is returned to you, check if the measurement is stopped (the light flashes twice every ten seconds or not at all in case the batteries are discharged), remove the

batteries and place the Compact Flash Card in the reader unit. Copy the AMS files to a designated directory. Use the same name for the directory as was used as a subject identifier. It is best to backup the original '.5fs' AMS-data files as soon as possible (extension '.5fs' discriminates the version 5fs AMS-data files from the '.ams' files generated by previous versions).

If the recording has been interrupted by the experimenter or by the subject, multiple .5fs files with different start times will be generated Use the AmsMerge tool to concatenate the .5fs files into a single .5fs file that spans the entire recording. Interruptions will be marked in this file as hold-continue periods.

Processing VU-AMS.5fs data
To further process the data you need to convert the raw '.5fs' AMS-data files to a format of choice, using the AmsPreProcessor program. Different formats are supported including Biopac, ASCII, EDF and EDF+.

The default is to convert the files to the native VU-AMS format. Native format creates a different file for each of the signals which is visible in the file name e.g.
0603001_03131202$DZ.bch;
0603001_03131202$DZDT.bch;
0603001_03131202$ECG.bch;
0603001_03131202$MYA.bch;
0603001_03131202$SCL.bch;
0603001_03131202$Z0.bch;
0603001_03131202.amsinv.
The binary amsinv (AMS inventory) file indicates the exact times of event button pushes and restarts).

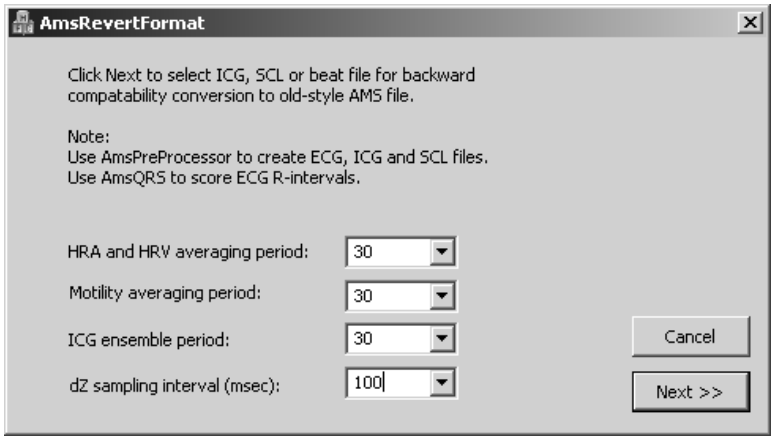


After conversion to native AMS format **FIRST** extract the IBI time series from the ECG signal. This is done with the AmsQRS program. The AmsQRS program displays the cardiotachogram of the complete recording in the top panel and the raw ECG signal in the lower panel. The middle panel also displays the cardiotachogram, but only for the interval selected in the top panel.

Clicking in the top panel will automatically scroll the middle and lower panel to the corresponding point in time. Visual inspection of the top panel will rapidly identify 'spikes' which can occur because an R-wave was missed and/or a T-wave was used instead. The spikes can be corrected in the lower window by dragging the cursor to the correct R-wave peak. A single left-click in the ECG panel will automatically insert a new R-peak cursor at the selected location. A single right-click on an existing cursor will remove that cursor. The left and right arrow keys of the keyboard allow you to step through all scored R-peaks. The active (blue) cursor can also be deleted by pressing the delete key. The corrected time series is saved in the '.beat' file. Detailed information on how to tailor automatic scoring is found under the 'Help' option of the AmsQRS program.

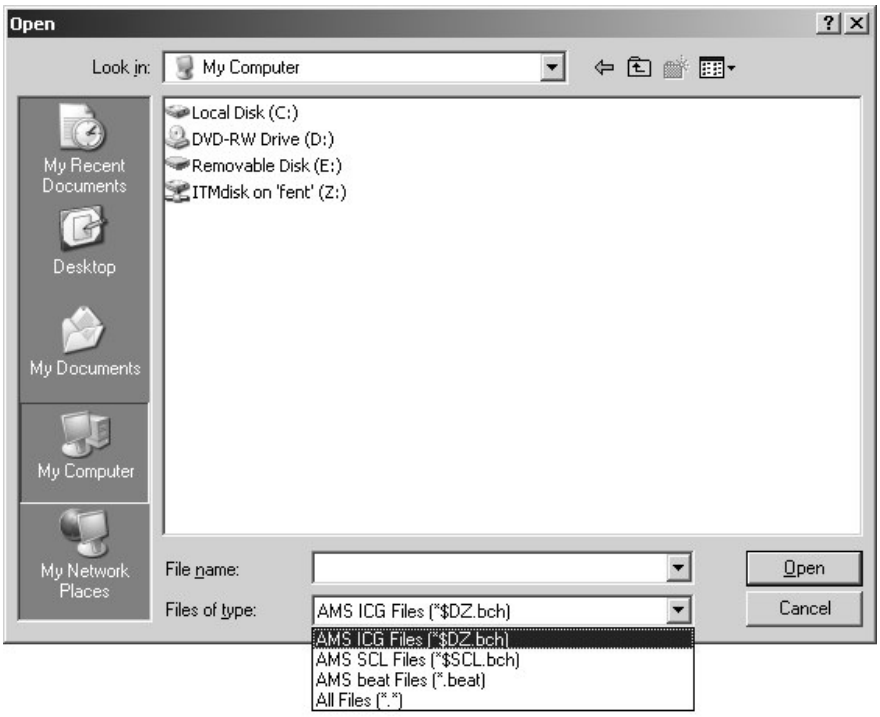
NOTE: All time spent correcting the IBI time series is well spent, since it is the basis of many other variables extracted from the VU-AMS.

How to score IBI, PEP and RSA in VU-AMS.5fs data?
After corrections with the AmsQRS program, the AMS.5fs signals can be converted to the old VU-AMS file format of the VU-AMS 4.6 series (.ams) with the AmsRevertFormat program. The immediate advantage of this is that all existing software for labeling (AMSGRA) and impedance scoring (AMSIMP) and respiration scoring (AMSRES) is now available. Manual for these programs are on the website (www.psy.vu.nl/vu-ams).

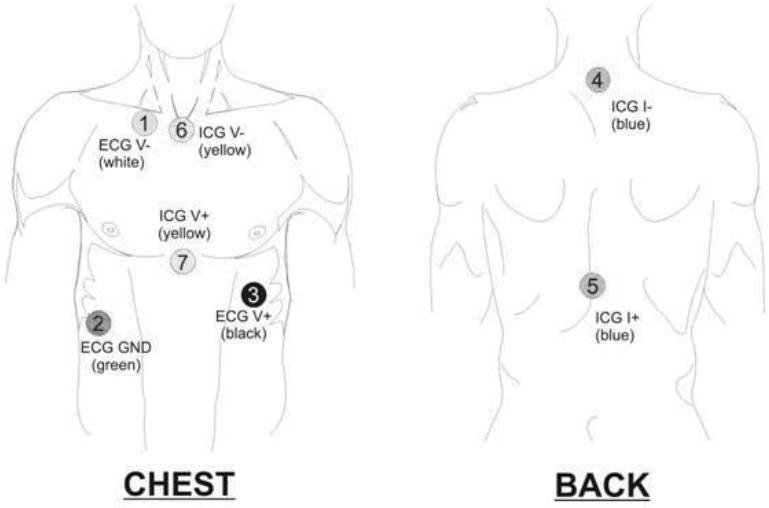


The VU-AMS 4.6 series did not yet combine ECG/SCL and ECG/ICG in a single device. You will have to choose the appropriate signals at the AmsRevertFormat option screen. For instance to create an .ams file with ECG/ICG signals use the following settings in AmsRevertFormat:

Then save the file as an impedance recording ($DZ.bch).



Appendix III: How to attach the VU-AMS.5fs?



Attachment of the ECG/ICG electrodes
Clean the skin at the 7 positions indicated in the figure. Rub the skin firmly with an alcohol soaked tissue or, if alcohol is not available, use a clean dry tissue. Attach an electrode by pressing the sticky plastic brim of the electrode on the skin and subsequently pushing the metal stud at the center of the electrode firmly, to properly spread the contact gel.

ECG:

1. (V-) Slightly below the right collar bone 4 cm to the right of the sternum
2. (GND) On the right side, between the lower two ribs
3. (V+) On the left side, on the ribcage, about 4 cm (1.3") below the nipple

ICG:

4. (I-) At the back, on the spine, at least 3 cm (1") above electrode 6
5. (I+) At the back, on the spine, at least 3 cm (1") below electrode 7
6. (V-) At the top end of the sternum, between the tips of the collarbones
7. (V+) At the low end of the sternum, where the ribs meet

Attachment of the lead wires and lead wire connector
Attach the lead wires to the electrodes according to the color -coding scheme in the figure above. Next, the blue ECG/ICG lead wire connector has to be plugged in the blue socket.

Starting the measurement by plugging in
The VU-AMS device is always on standby. Measurement will (re-)start after you plug in the lead wire connector and press the event button for about three seconds. A beep will be heard to acknowledge the start of the recording and the green light will start flashing about once every three seconds.

Wearing the device
Put the VU-AMS device in its carrier bag with the lead wire connector facing up. Fasten the device with the Velcro strap in the bag and gird it on with the VU-AMS belt (if it is more convenient, you can also use your own belt). Make sure the device remains in a vertical position as much as possible.

Marking special events
A small black button is placed on top of the VU-AMS device next to the two lead wire plug connectors. To mark a special event, push this button for about one second. Pushing it will be confirmed by a short beep.

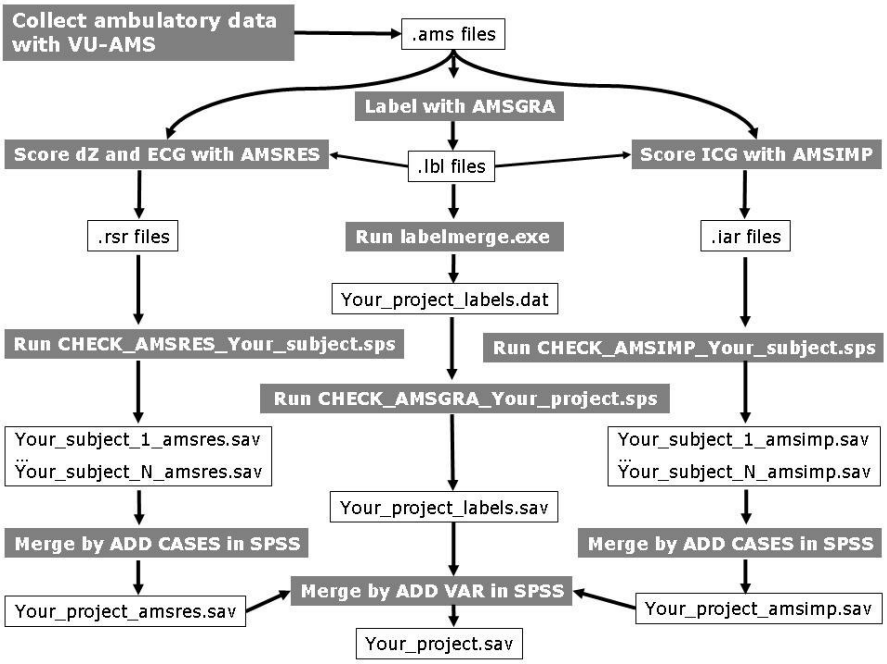
Stopping the measurement
If you want to stop the measurement temporarily (e.g. for taking a shower) press the event button for at least 3 seconds until the green light ceases flashing. Next, unplug the lead wire connector from its socket and disconnect the lead wires from the electrodes. The electrodes themselves are waterproof and need not be removed from the skin. To restart the measurement, simply follow the instructions above starting at 'Attachment of the lead wires'.

Still working?
A small indicator light on top of the device will be flashing about once every three seconds as long as the VU-AMS is recording.

Something is going wrong.
• The green light is flashing very rapidly
Diagnosis: The Compact Flash card is not (properly) installed.
Solution: Install the Compact Flash card in the proper way.
• The green light is flashing rapidly
Diagnosis: The battery lid is not (properly) fastened.
Solution: Fasten the battery lid in the proper way.
• You hear a double beep (the ‘alert beep’).
Diagnosis: The battery voltage is becoming low.
Solution: Replace the batteries with fresh ones.
• An electrode comes off, a lead wire gets disattched, or the lead wire connector is pulled out by accident.
Solution: No worries. Just attach the electrode again (use a spare one if necessary), reattach the lead wire, or plug the connector back into the socket.

Otherwise, for online help dial the number printed on your diary.

Appendix IV: Data reduction strategy (based on AMGRA labeling)
A graphical depiction of a strategy to handle VU-AMS data proven fruitful in our own research is given below. We combine AMS software with SPSS scripts:



How?
When you performed all labeling (AMSGRA) and all scoring (AMSIMP, AMSRES) of the VU-AMS data you can download the four SPSS scripts provided here to optimally organize your data under SPSS. Make a copy of each script where you change "generic" in the file names to "Your_project" or "Your_subject" (see below) and where you change the extension of the script files from .txt to .sps.

Then work with these copies only, i.e. with
- LABEL_VARIABLE&VALUES_Your_project.sps
- CHECK_AMSGRA_allsubjects_Your_project.sps
- CHECK_AMSRES_Your_subject_1.sps
- CHECK_AMSIMP_Your_subject_1.sps

In these SPSS scripts, a number of critical assumptions are made regarding the structure of your AMS data, specifically the file names of the AMS-files. If you do not meet these assumptions it may need substantial effort to get these scripts to run!! So much so that you should consider renaming your file names to meet these assumption.

ASSUMPTIONS:
1. The AMS file names are always of the same length (7 digits).
2. The AMS file names are numerical only (e.g. 0603001).
3. The AMS file names identify the subject (and the session), i.e. 0045601.ams for subject 456 at the first test session or 0003603.ams for subject 36 at the third test session.
4. You do not use AMSRES or AMSIMP before labeling the data with AMSGRA.
5. You did not have the labels in AMSGRA overlap in time.

FIRST
Provide appropriate variable and value labels for your database in the SPSS script LABEL_VARIABLE&VALUES_Your_project.sps. The examples given in this script should be able to guide you in doing this correctly.

SECOND
Concatenate the AMSGRA .lbl-files to yield a single large ASCII input text file for SPSS, which we refer to further as Your_project_labels.dat. To concatenate the AMGRA .lbl-files use the tool 'labelmerge.exe' under the MS-DOS prompt (see other downloadable files on the VU-AMS website). It removes the five lines of header information at the start of the .lbl-files. It then inserts the name of the .lbl-file (which according to assumption 3 is a subject identifier) at the beginning of each line. Check that the string 'LBL' does not occur in Your_project_labels.dat. In the CHECK_AMSGRA_allsubjects_Your_project.sps script, change the file names and directory structure used in the GET DATA and SAVE OUTFILE commands to the appropriate file names and directory structure of your own project. This is done by changing the strings "Your_full_directory_tree" and "Your_file_with_all_subjects" in the DEFINE statements at the top of the script. Then run the SPSS script to create the target SPSS file Your_file_with_all_subjects.sav.

THIRD
Now run the two remaining jobs SEPARATELY ON EACH SUBJECT. For AMSRES data, you generate a new script for each subject that in turn yields a separate target SPSS file for each subject 1 to N: Your_subject_1_AMSRES.sav, Your_subject_2_AMSRES.sav until Your_subject_N_AMSRES.sav. For AMSIMP data, you generate a new script for each subject that in turn yields the SPSS target file Your_subject_1_AMSIMP.sav. Note that in the CHECK_AMSRES_Your_subject.sps and CHECK_AMSIMP_Your_subject.sps scripts you need to change the directory structure used in the GET DATA and SAVE OUTFILE commands to the appropriate directory structure of your own project. For each of the subjects in the project you need to change the file name (i.e. subject_1, subject_2, etc) to the appropriate file name. Finally, in the CHECK_AMSIMP_Your_subject.sps scripts you may want to set the electrode distance separately for each subject by a DEFINE. When all subjects are done, use SPSS to MERGE (ADD CASES) Your_subject_1_AMSRES.sav to Your_subject_N_AMSRES.sav files into a single SPSS file that now contains AMSRES data of all subjects. We refer to this file as Your_project_AMSRES.sav. Do similar for the AMSIMP files of all subjects to obtain Your_project_AMSIMP.sav.

FOURTH
You can now MERGE the data from all three domains (Your_project_labels.sav, Your_project_AMSRES.sav and Your_project_AMSIMP.sav) using the interactive menu of SPSS. It is critical that you use the subject identifier variable and the category identifiers as the BREAK variables in the MERGE (ADD VAR) command.

Appendix V: SPSS scripts

LABEL_VARIABLE&VALUES_Your_project.sps

```
** This SPSS include file is used by other VU-AMS SPSS jobs to label the time
** periods over which the data have been aggregated. Aggregation uses the categories
** that were used in the label configuration file (label.cfg) during labeling under
** AMSGRA. These categories and there levels will be completely study-specific
*################################################
** This means that you need to change EVERYTHING below to make this job
** properly reflect your own study protocol and labeling. The good thing, however, is
** that you need to do this only ONCE
*################################################
** An example of a valid job for a specific study is given below. The study had five
** categories, each with multiple levels.
*********************************************************************************
*** ADD STUDY SPECIFIC VARIABLE LABELS.
*********************************************************************************.
VARIABLE LABEL posture 'main posture during labeled period'.
VARIABLE LABEL physical 'physical load during labeled period'.
VARIABLE LABEL activity 'main activity during labeled period'.
VARIABLE LABEL location 'location of subject during labeled period'.
VARIABLE LABEL social 'social situation during labeled period'.
EXECUTE.
*********************************************************************************
*** ADD STUDY SPECIFIC VALUE LABELS.
*********************************************************************************.
VALUE LABELS posture
            10          'lying'
            11          'sitting'
            12          'standing'
            13          'walking'
            14          'lie/sit'
            15          'sit/stand'
            16          'sit/stand/walk'
            17          'stand/walk'
            18          'bicycling'
            19          'unknown'.
EXECUTE.

VALUE LABELS physical
            20          'light physical activity'
            21          'medium physical activity'
            22          'heavy physical activity'
            23          'very heavy physical activity'
            24          'sleep'
            25          'unknown'.
EXECUTE.

VALUE LABELS activity
            30          'deskwork (PC)'
            31          'administrative work'
            32          'general activities at work'
            33          'household activities'
            34          'active transport (driving yourself)'
            35          'passive transport (passenger)'
            36          'telephone /talking business'
            37          'telephone/talking private'
```

```
            38          'reading / PC recreative'
            39          'eating / drinking'
            40          'watching television'
            41          'recreative activity'
            42          'sleep'
            43          'unknown'
            81          'sleep1'
            82          'sleep2'
            83          'sleep3'
            84          'sleep4'
            85          'sleep5'
            86          'sleep6'
            87          'sleep7'
            88          'sleep8'
            89          'sleep9'
            90          'sleep10'
            91          'sleep11em'.
EXECUTE.

VALUE LABELS location
            40          'work'
            41          'home'
            42          'outside'
            43          'friend'
            44          'on the road'
            45          'public'
            46          'hospital/medical doctor'
            48          'family elsewhere'
            49          'unknown'.
EXECUTE.

VALUE LABELS social
            50          'alone'
            51          'with SO'
            52          'with own kids'
            53          'with friends'
            54          'with colleagues'
            55          'with others'
            56          'with family'
            57          'unknown'.
EXECUTE.
```

CHECK_AMSGRA_allsubjects_Your_project.sps

```
SET PRINTBACK = OFF.

** File name = CHECK&_AMSGRA_generic.sps.
** Version July 2007.
** label Data File version 101.
** Some easy to locate DEFINEs that set the WORKING DIRECTORY, the input file with the
concatenated LBL-files of all subjects, and
** a file that defines the variable and value labels for the categories of your labeled periods.

DEFINE   !DIRY()     'C:\Your_full_directory_tree\' !ENDDEFINE.
DEFINE   !FILE()     'Your_file_with_all_subjects'  !ENDDEFINE.
DEFINE   !LABELF()  'label_VAR&VALUES_your_project'        !ENDDEFINE.
SET PRINTBACK = OFF.

***ATTENTION*****************************************************************.
** Although this job is fairly generic, it may need some adjustments to  fit your data.
** Search for the sections labeled with '@@@@@@' to bring this job in accordance
** with the protocol of your specific study and your own wishes regarding data
** handling (what to save and what not).
*****************************************************************************.
**SCRIPT HISTORY*************************************************************.
** Eco de Geus. Version 13-02-1996
** Modified for validation study AMS-Portapres by Harriette Riese
** Modified for applying under SPSSWIN 6.1 Tanja Vrijkotte Harriette Riese
** Modified for Slotervaartziekenhuis data 25 maart 1997 Harriette Riese
** Modified for OLVG data 1-7-98 Harriette Riese under SPSS7.5 under windows95.
** Modified for 'la nurses data complete' 7-4-99 Harriette Riese
** Modified for FFA-insuline 18-07-2002 Harriette Riese SPSS 11.0
** Modified for NETSAD 27-11-2002 Harriette Riese SPSS 11.0
** Modified for NETSAD 28-03-2003 Nina Kupper SPSS 11.5
** Modified for website vu-ams 03-02-2004 Nina Kupper SPSS 11.5
** Modified for Psychophysiology course 2006 Eco de Geus & Annebet Goedhart
** Modified for Rosa project Eco de Geus 01-04-2007
** Lay-out & Logic update Annebet Goedhart July 2007
*****************************************************************************.
**GENERAL DESCRIPTION********************************************************.
** This is a syntax file for SPSS for Windows version 13.
** INPUT: It will read a label.dat file with the concatenated LBL-files of all subjects.
** label.dat files are created by preprocessing individual LBL-files with
** 'labelmerge.exe' in DOS (see other downloadable files on the VU-AMS website).
** labelmerge.exe removes the 5 lines of header information at the start of the
** lbl-files. It then inserts the name of  the lbl-file at the beginning of each line.
** We assume that this file name acts as a 7-digit subject identifier.
** All processed ".lbl" files are then concatenated and the resulting file
** (with extension .dat) is read in SPSS to make a database of the labeled periods
** under AMSGRA, together with the average motility, heart rate and heart rate
** variability parameters for each of these labeled periods as found in the ".lbl" file.

** ACTION: The AMSGRA data are read into SPSS.
** LIST OF VARIABLES TO BE READ:
** ppname          = subject identification
** strtdate        = start date of the labeled period in dd:mm:yy
** enddate         = end date of the labeled period in dd:mm:yy
** strttime        = start time of the labeled period in hh:mm:ss
** endtime         = end time of the labeled period in hh:mm:ss
**                  (Don't make too much of 'seconds' here, since labeling accuracy is
```

```
**                  usually not more than 30 s)
** label 1 .. n = Here a number of labeling categories may be read; the exact number
**                  depends on the configuration of your label.cfg file
** hramean         = the mean of the average HRs found in this labeled period
**                  Yes, this is an average of averages! Each 30 seconds (by default) an
**                  average heart rate is computed from all interbeat intervals (IBIs)
**                  found in that period. The variable 'hrmean' gives the mean of these
**                  averages over the entire labeled period. Please note that we have no
**                  information on the number or the integrity of IBIs constituting the
**                  30-s average HR!  Note that 30 seconds is the default, you may
**                  have changed it, but the same principle will apply. To get the
**                  complete IBI time series you can convert the AMS file to an ascii
**                  file containing all ibi's by AMSASC.
** hra#            = the number of average HRs found in this labeled period
** hramin          = the lowest average HR found in this period
** hramax          = the highest average HR found in this period
** hravar          = the variance in the average HRs found in this period
** hrasd           = the standard deviation of the average HRs found in this period
** msdmean         = the mean of all 30-second msd scores found in this labeled period
**                  The same 30-second fragment (by default) that is used to compute
**                  the average heart rate is used to compute the Mean Square of
**                  Successive Differences in interbeat interval (in ms). The latter index
**                  of heart rate variability may be used to get a quick impression of vagal
**                  tone. Again, make sure to note that we have no information on the
**                  number or the integrity of IBIs constituting the mssd.
** msd#            = the number of average HRs (and thus msds) found in this labeled
**                  period
** msdmin          = the lowest msd found in this period
**                  Yuck! A bug in AMSGRA (up to version 4.4) sometimes produces
**                  negative values here. See below on how to deal with this.
** msdmax          = the highest msd found in this period
** msdvar          = the variance in the msds found in this period
** msdsd           = the standard deviation of the msds found in this period
** motmean         = the average of all motility scores found in this labeled  period.
**                  Each motility score represents the sum of vertical acceleration over a
**                  30-s period (30 seconds is thedefault, you may have changed it,
**                  even independently of the period for heart rate averaging, but the
**                  same principle will apply).
** mot#            = the number of 30-s motility scores found in this labeled period
** motmin          = motility during the 30-second fragment with lowest motility
** motmax          = motility during the 30-second fragment with highest motility
** motvar          = the variance in the motility scores found in this period
** motsd           = the standard deviation of motility scores found in this period
** ibimean         = the mean of the average IBIs found in this labeled period
**                  Yes, this is an average of averages! Each 30 seconds (by default) an
**                  average IBI is computed from all  interbeat intervals found in that
**                  period. The variable 'ibimean' gives the mean of these averages over
**                  the entire labeled period. Please note that we have no information on
**                  the number or the integrity of IBIs constituting the 30-sec average
**                  IBI!  Note that 30 seconds is the default, you may have changed it,
**                  but the same principle will apply. To get the complete IBI time series
**                  you can convert the AMS file to an ASCII file containing all IBIs by
**                  using AMSASC.
** ibi#            = the number of average IBIs found in this labeled period
** ibimin          = the lowest average IBIs found in this period
** ibimax          = the highest average IBIs found in this period
** ibivar          = the variance in the average IBIs found in this period
** ibisd           = the standard deviation of the average IBIs found in this period
```

```
** Outliers are detected, variables and values are labeled and indices of total recording
**    time and data loss are added.
** OUTPUT: The resulting .SAV file will consider each labeled period to be a "case".
** Therefore, per subject there will be a PEP, SV etc for each labeled period.
*************************************************************************.
** @@@@@@ FILE AND DIRECTORY STRUCTURE**********************.
** WE ASSUME THAT FILE NAMES ARE EXACTLY 7 CHARACTERS LONG
** & REFLECT THE ID OF THE SUBJECT NOTE THAT THE FILENAMES
** USED IN DATA LIST AND SAVE OUTFILE COMMANDS MUST BE
** CHANGED TO CORRESPOND TO YOUR OWN FILENAMES AND
** DIRECTORY STRUCTURE THIS CAN BE DONE BY CHANGING THE
** DEFINE STATEMENTS AT THE START OF THIS JOB
*************************************************************************.
** @@@@@@ PROJECT SPECIFIC LABELING*************************.
** The job text below assume that you used the following categories to label the data:
** posture= a code stating the dominant posture during that period (10 levels)
** physical load      = a code indicating the level of physical load (6 levels)
** activity           = type of activity the subject is engaged in (24 levels)
** location           = a code for the location of the subject (9 levels)
** social situation   = indicating the social situation the subject is in (8 levels)
**
** This is unlikely to correspond to your own categories. Change the command syntax
** accordingly, i.e. change
** posture 47-51 F5.0 physical 52-55 F4.0 activity 56-59 F4.0 location 60-63 F4.0
** social 64-67 F4.0
**
** to the appropriate description of the categories you used to label the data
*************************************************************************.
***WARNING FOR POTENTIAL PROBLEMS
*************************************************************************.
** The largest problem that arises during the GET DATA statement is that the input
** has a comma-notation for floating point notation (e.g. 8,03) whereas SPSS expects
** a dot-notation (8.03) or vice versa. When the need arises: In the control panel of
** Windows select 'regional and language options' / 'customize' and set the decimal
** symbol for numbers to 'dot'.
*************************************************************************.
***** READING MULTIPLE LBL-FILES ***********************************************************************.
TITLE 'PROCESSING VU-AMS LBL-FILES CREATED WITH AMSGRA AND CONCATENATED WITH labelMERGE'.

GET DATA  /TYPE = TXT /FILE = !DIRY+!FILE+'.dat'
 /FIXCASE = 5  /ARRANGEMENT = FIXED  /FIRSTCASE =1  /IMPORTCASE = ALL
 /VARIABLES =
 /1 subject 0-6 F7.0 strtdate 11-18 EDATE8  strttime 20-27 TIME11.2 enddate 30-37 EDATE8 endtime
39-46 TIME11.2 posture 47-51 F5.0 physical 52-55 F4.0 activity 56-59 F4.0 location 60-63 F4.0 social
64-67 F4.0
/2 hra# 16-24 F9.2 hramin 25-33 F9.2 hramax 34-42 F9.2 hramean 43-51 F9.2 hravar 52-60 F9.2 hrasd
61-69 F9.2
/3 msd# 16-24 F9.2 msdmin 25-33 F9.2 msdmax 34-42 F9.2 msdmean 43-51 F9.2 msdvar 52-60 F9.2
msdsd 61-69 F9.2
/4 mot# 16-24 F9.2 motmin 25-33 F9.2 motmax 34-42 F9.2 motmean 43-51 F9.2 motvar 52-60 F9.2
motsd 61-69 F9.2
/5 ibi# 16-24 F9.2 ibimin 25-33 F9.2 ibimax 34-42 F9.2 ibimean 43-51 F9.2 ibivar 52-60 F9.2 ibisd 61-
69 F9.2 .
CACHE.
EXECUTE.
*************************************************************************.
*****ADD VARIABLE LABELS*********************************************.
VARIABLE LABEL strtdate 'start date of the labeled period in dd:mm:yy'.
```

```
VARIABLE LABEL enddate 'end date of the labeled period in dd:mm:yy'.
VARIABLE LABEL strttime 'start time of the labeled period in hh:mm:ss'.
VARIABLE LABEL endtime 'end time of the labeled period in hh:mm:ss'.
VARIABLE LABEL hra# 'the number of 30-second average HRs found during this period'.
VARIABLE LABEL hramin 'the lowest 30-second average HR found during this period'.
VARIABLE LABEL hramax 'the highest 30-second average HR found during this period'.
VARIABLE LABEL hramean 'the mean HR across this period'.
VARIABLE LABEL hrasd 'the standard deviation of the 30-second average HRs found during this period'.
VARIABLE LABEL msdmin 'the lowest 30-second average RMSSD found during this period'.
VARIABLE LABEL msdmax 'the highest 30-second average RMSSD found during this period'.
VARIABLE LABEL msdmean 'the mean RMSSD across this period'.
VARIABLE LABEL msdsd 'the standard deviation of all 30-second RMSSD averages found in this period'.
VARIABLE LABEL motmin 'motility during the 30-second fragment in this period with lowest motility'.
VARIABLE LABEL motmax 'motility during the 30-second fragment in this period with highest motility'.
VARIABLE LABEL motmean 'the average motility across this period'.
VARIABLE LABEL motsd 'the standard deviation of all 30-second motility averages found during this
period'.
VARIABLE LABEL IBImin 'IBI in the 30-second fragment with fastest heart rate in this period '.
VARIABLE LABEL IBImax 'IBI in the 30-second fragment with slowest heart rate in this period '.
VARIABLE LABEL IBImean 'the average IBI across this period'.
VARIABLE LABEL IBIsd 'the standard deviation of all 30-second IBI averages found during this period'.
EXECUTE.
*************************************************************************.
** VALUE AND VARIABLE LABELING ***********************************************************************.
** Use an INCLUDE FILE to supply the correct variable and value labels for (all of)
** the numerical codes used when labeling the AMS-file with AMSGRA. Note that
** the file name needs to be changed to the name of your study specific include file
** that you prepared before running this job. In the example below the include file
** supplies VARIABLE names and VALUES for posture, physical load, type of the
** activity, location and social situation. This may, of course, be different in
** your include file.
*************************************************************************.
INCLUDE !DIRY+!LABELF+'.sps'.
**@@@@ CATEGORY DEPENDENT CHECKS OF LABELING IN AMSGRA
*************************************************************************.
** The checks below assumes that you used the following five CATEGORIES for
** labeling with AMSGRA;
** posture             = a code stating the dominant posture during that period (10 levels)
** physical load = a code indicating the level of physical load (6 levels)
** activity            = type of activity the subject is engaged in (24 levels)
** location            = a code for the location of the subject (9 levels)
** social situation    = indicating the social situation the subject is in (8 levels)
** This is unlikely to correspond to your own categories. Change the command syntax
** accordingly, i.e. change
**           posture physical activity location social
** to the appropriate description of the categories you used to label the data
*************************************************************************.
**CHECKS OF LABELING IN AMSGRA *********************************************************************.
** Carefully check the frequency distribution of the labels used.
** Identify the problematic frequencies and go back to the original diary data where
** needed to resolve this.
FREQUENCIES
  VARIABLES=posture physical activity location social
  /ORDER=  ANALYSIS .

** Test for events that are unlike to happen (e.g. watching television while using
** public transportation; being asleep while driving a car etc. If they occur check the
** original diaries whether a false entry was made during labeling and resolve this.
```

```
CROSSTABS
  /TABLES=activity BY posture
  /FORMAT= AVALUE TABLES
  /CELLS= COUNT .
EXECUTE.
CROSSTABS
  /TABLES=physical  BY posture
  /FORMAT= AVALUE TABLES
  /CELLS= COUNT .
EXECUTE.
CROSSTABS
  /TABLES=physical  BY location
  /FORMAT= AVALUE TABLES
  /CELLS= COUNT .
EXECUTE.
CROSSTABS
  /TABLES=social  BY location
  /FORMAT= AVALUE TABLES
  /CELLS= COUNT .
EXECUTE.
*************************************************************************.
**REMOVING EMPTY LABELS*************************************************.
** Remove labeled periods that have no physiological data. This occurs in between
** hold and continues.
SELECT IF hramin ~= 0.
SELECT IF hra#  > 1.
EXECUTE .
*************************************************************************.
**OUTLIER DETECTION*****************************************************.
** Check whether your physiological variables remain within their plausible
** physiological range:
**  HRAMEAN                    = the average HR  35-200 bpm
**  HRAMIN                     = the lowest HR   30-180 bpm
**  HRAMAX                     = the highest HR  50-240 bpm
**  HRASD            = HR standard deviation  1-25 bpm
**  MOTMEAN          = average motility of subject *device dependent*
**  MOTMIN                     = lowest motility *device dependent*
**  MOTMAX                     = highest motility *device dependent*
**  MOTSD                      = standard deviation *device dependent*
**  MSDMEAN                    = the average MSSD 3-195
**  MSDMIN                     = lowest MSSD      0-200
**  MSDMAX                     = highest MSSD     5-550
**  MSDSD            = MSSD standard deviation 0-90
**  This is a topic that is subject to personal opinion, you must ultimately decide how to deal ** with
outliers yourself.

FREQUENCIES
  VARIABLES=HRAMEAN HRASD HRAMAX HRAMIN MSDMEAN MSDSD
MSDMAX MSDMIN
  /FORMAT=LIMIT (1)
  /PERCENTILES= 5 95
  /STATISTICS=STDDEV VARIANCE RANGE MINIMUM MAXIMUM MEAN
  /HISTOGRAM  NORMAL.
EXECUTE.
```

```
** Generic exclusion criteria.
SELECT IF (35 < HRAMEAN < 200).
SELECT IF (MSDMAX < 550).
SELECT IF (MSDMIN < 200).
SELECT IF (1 < HRASD < 25).
EXECUTE.
** Project specific exclusion criteria.
** @@@@@ (FILL IN AS REQUIRED)
EXECUTE.
*************************************************************************.
**SAVING DATA************************************************************.
** We happily throw away redundant or unimportant information at this point.
** DROP  mot# msd# (number of 30-s averages in each of the labeled periods is
** already indicated by hra#, which we keep)
** DROP hravar  motvar msdvar (variance, we already have SD)
** Compute the duration of each of the labeled periods and adds this variable
*************************************************************************.
FORMATS strttime endtime (TIME11.2).
IF (strtdate eq enddate) duration =  CTIME.MINUTES(endtime - strttime).
IF (strtdate ne enddate) duration =  CTIME.MINUTES(endtime + (TIME.HMS(24,0,0) - strttime)).
EXECUTE.
VARIABLE label duration 'Duration of this labeled period in minutes (NB: floating point notation)'.
EXECUTE.

SAVE OUTFILE=!DIRY+!FILE+' + '_labels.sav'/ DROP mot# msd# ibi# hravar motvar msdvar ibivar.
EXECUTE.
```

CHECK_AMSRES_Your_subject_1.sps

```
** File name = CHECK_AMSRES_singlesubject_generic.sps
** Version July 2007
** AMS version 4.6 / 5fs (back conversion)
** Some easy to locate DEFINEs that set the WORKING DIRECTORY, the
** RSR-file to be checked, and a file that defines the variable and value labels for the
** categories of your labeled periods.

DEFINE   !DIRY()     'C:\Your_full_directory_tree\'          !ENDDEFINE.
DEFINE   !FILE()     'Your_file_for_subject_1'              !ENDDEFINE.
DEFINE   !LABELF()  'label_VAR&VALUES_your_project'      !ENDDEFINE.

***ATTENTION*****************************************************************.
** Although this job is fairly generic, it may need some adjustments to  fit your data.
** Search for the sections labeled with '@@@@@' to bring this job in accordance
** with the protocol of your specific study and your own wishes regarding
** data handling (what to save and what not).
******************************************************************************.
**SCRIPT HISTORY*************************************************************.
** Original version 1996 Eco de Geus
** [many hacks by Riese & Vrijkotte]
** Revised extensively by Dolf de Boer 2004
** Modified for Psychophysiology course 2006 Eco de Geus & Annebet Goedhart
** Updated for thesis Annebet Goedhart, summer 2007
******************************************************************************.
**GENERAL DESCRIPTION********************************************************.
** This is a syntax file for SPSS for Windows version 13.
** INPUT: It will read individual ".rsr" files into SPSS.
** ACTION: This syntax file is an example of how one could use SPSS for the
** detection of outliers and final aggregation of the data obtained from AMSRES.
** This syntax has been developed in our department through years of experience and
** final improvements have been made and tested in a dataset of the ambulatory
** monitoring of >1000 participants. The selection criteria in this syntax have
** provided satisfactory results for this dataset. However, for other populations,
** circumstances or research protocols, different criteria might be required.
** First the raw data is imported into SPSS. This DATA LIST statement will differ
** according to the settings used when creating  the .rsr file (see "Edit", "Options"
** in AmsRes).
** @@@@@ WE ASSUME THAT ALL OUTPUT FIELDS HAVE BEEN
** GENERATED, i.e. ALL BOXED TICKED, WITH EXCEPTION OF
** 'write file header'. ALSO WE ASSUME THAT THE BREATH IS
** TIMESTAMPED WITH A LONG DATE/TIME FORMAT. FINALLY WE
** ASSUME THAT 5 DIFFERENT CATEGORIES WERE USED IN LABELING
** THE DATA UNDER AMSGRA
** In short the file header of the AMSRES report file would have looked like
** column  1 (width= 8): Subject ID
** column  2 (width =7): Breath Number
** column  3 (width= 7): Beat-to-beat sequence number (starting at 0)
** (historic/no longer used)
** column  4 (width= 9): Date (dd-mm-yy)
** column  5 (width= 9): Time (hh:mm:ss)
** column  6 (width= 6): Inspiration time [ms]
** column  7 (width= 6): Expiration time  [ms]
** column  8 (width= 6): Shortest accelerating inspiration [ms]
** column  9 (width= 6): Longest decelerating expiration [ms]
** column 10 (width= 6): Respiration Rate [ms]
** column 11 (width= 6): Respiratory Sinus Arrhythmia (RSA) [ms]
```

```
** column 12 (width= 6): Mean IBI (across the duration of the breath) [ms]
** column 13 (width= 8): correlation between mean IBI and RSA
** (running average on 30 s)
** column 14 (width= 8): dZ Amplitude - raw signal (min) [Ohm]
** column 15 (width= 8): dZ Amplitude - raw signal (max) [Ohm]
** column 16 (width= 8): dZ Amplitude - filtered signal (min) [Ohm]
** column 17 (width= 8): dZ Amplitude - filtered signal (max) [Ohm]
** column 18 (width= 2): Rejected ('R') or accepted ('A')
** column 19 (width= 4): label number (0 if N/A)
** column 20+ (width=99): Values in all categories used for labeling (integers)
**
** LIST OF VARIABLES TO BE READ:
** subjectSubject ID
** breath Breath Number
** bbb              Beat-to-beat sequence number (starting at 0)
** date             Date       Date (dd-mm-yy)
** time             Time (hh:mm:ss)
** insp             Inspiration time [ms]
** exp              Expiration time  [ms]
** shortibi         Shortest accelerating inspiration [ms]
** longibi Longest decelerating expiration [ms]
** rr               Respiration Rate [ms]
** rsa              Respiratory Sinus Arrhythmia (RSA) [ms]
**                          -1 undetectable 'shortest IBI'
**                          -2 undetectable 'longest IBI'
**                          -3 both 'longest IBI' and 'shortest IBI' were undetectable
**                          -4 'longest IBI' is shorter than the 'shortest IBI'
** ibi              Mean IBI (across the duration of the breath) [ms]
** ibirsa_corr      correlation between mean IBI and RSA (running average on 30 s)
** dzMinR dZ Amplitude - raw signal (min) [Ohm]
** dzMaxRdZ Amplitude - raw signal (max) [Ohm]
** dzMinf  dZ Amplitude - filtered signal (min) [Ohm]
** dZMaxf dZ Amplitude - filtered signal (max) [Ohm]
** reject  Rejected ('R') or accepted ('A')
** labelnr label number (0 if N/A)
** (labels) Values in all categories used for labeling (integers)
**

** VARIABLES ADDED:
** RSAZERO is calculated out of shortibi and longibi. In contrast to the original RSA
** value, values for RSAZERO are set to zero when neg=1 (absence of a valid
** shortibi and/or longibi) or reverse=1 (shortibi>longibi). In our experience, a lot
** of cases of neg=1 or reverse=1 are due to a true low RSA and RSA should be set
** to zero. We also keep the original RSA value (RSA). For breaths with neg =1 or
** reverse=1, however, RSA is interpreted to be missing and these breaths are
** excluded.
**
** DATA LOSS PARAMETERS Outliers are detected in various procedures are
** removed; an indicator of the total data loss caused by each procedure is temporarily
** added.
**
** OUTPUT: The resulting .SAV file will aggregate across labeled periods. Each
** labeled period will considered to be a "case".
** Therefore, per subject there will be a RSA, RR etc for each labeled period. These
** data will be "clean".
*************************************************************************.
** @@@@@ FILE AND DIRECTORY STRUCTURE**********************.
** WE ASSUME THAT FILE NAMES ARE EXACTLY 7 CHARACTERS LONG
```

```
** & REFLECT THE ID OF THE SUBJECT  NOTE THAT THE FILENAMES
** USED IN DATA LIST AND SAVE OUTFILE COMMANDS MUST BE
** CHANGED TO CORRESPOND TO YOUR OWN FILENAMES AND
** DIRECTORY STRUCTURE THIS CAN BE DONE BY CHANGING THE
** DEFINE STATEMENTS AT THE START OF THIS JOB
*****************************************************************************.
** @@@@@ PROJECT SPECIFIC LABELING*****************************.
** The job text below assume that you used the following categories to label the data:
** posture= a code stating the dominant posture during that period (10 levels)
** physical load      = a code indicating the level of physical load (6 levels)
** activity           = type of activity the subject is engaged in (24 levels)
** location           = a code for the location of the subject (9 levels)
** social situation = indicating the social situation the subject is in (8 levels)
**
** This is unlikely to correspond to your own categories. Change the command syntax
** accordingly, i.e. change
**          posture 129-133 physical 134-137 activity 138-141 location 142-145
**          social 146-149
** to the appropriate description of the categories you used to label the data
*****************************************************************************.
***WARNING FOR POTENTIAL PROBLEMS
*****************************************************************************.
** The largest problem that arises during the GET DATA statement is that the input
** has a comma-notation for floating point notation (e.g. 8,03) whereas SPSS expects
** a dot-notation (8.03) or vice versa. When the need arises: In the control panel of
** Windows select 'regional and language options' / 'customize' and set the decimal
** symbol for numbers to 'dot'.
** Another nicety is that SPSS in some version stopped counting empty lines as 'true'
** lines. This may mean that you need to adjust the FIRSTCASE parameter in the
** GET DATA statement.
*****************************************************************************.
TITLE 'PROCESSING VU-AMS RSR-FILES CREATED WITH AMSRES'.
SUBTITLE 'READING THE AMBULATORY BREATH-TO-BREATH RR, RSA AND IBI DATA'.

DATA LIST FILE= !DIRY+!FILE+'.rsr' FIXED RECORDS=1
/ subject 1-7 breath 8-15 bbb 16-22 date 23-31 (DATE) time 33-40 (TIME)
insp 41-46 exp 47-52 shortibi 53-58 longibi 59-64 rr 65-70 (2) rsa 71-76 ibi 77-82 rrrsa_corr 83-90 (4)
DzMinr 91-98 (4) DzMaxr 99-106 (4) dzMinf 107-114 (4) dzMaxf 115-122 (4) reject 124 (a) labelnr 125-
128 posture 129-133 physical 134-137 activity 138-141 location 142-145 social 146-149.
EXECUTE.

**OUTLIER DETECTION*************************************************.
** Now we apply various selection criteria to remove nonreliable data for this subject.
** Exact documentation of the data-loss after each selection is done with the
** cases_1 .. cases_n variables
*****************************************************************************.
COMPUTE cases_1 = $CASENUM.
VARIABLE LABLE cases_1 'Total number of breaths'.
AGGREGATE  /OUTFILE=*  MODE=ADDVARIABLES  OVERWRITE=YES /BREAK=subject /cases_1 =
MAX(cases_1).

** The first two breaths at the beginning of the signal have to rejected because the
** FIR-filter needs some samples to start-up.

SELECT IF breath > 2.
SELECT IF labelnr > 0.
EXECUTE.
```

```
COMPUTE cases_2 = $CASENUM.
VARIABLE LABLE cases_2 'Excluding the unlabeled parts of the recording'.
AGGREGATE  /OUTFILE=*  MODE=ADDVARIABLES  OVERWRITE=YES /BREAK=subject /cases_2 =
MAX(cases_2).

**With this statement, we exclude all breaths that have been rejected in AmsRes.
** For rejection criteria, see the AMSRES manual.

SELECT IF (reject = 'A').
EXECUTE.

COMPUTE cases_3 = $CASENUM.
VARIABLE LABLE cases_3 'Excluding breaths that were interactively rejected in AMSRES'.
AGGREGATE  /OUTFILE=*  MODE=ADDVARIABLES  OVERWRITE=YES /BREAK=subject /cases_3 =
MAX(cases_3).

** Here we exclude off hand expirations and inspirations that we consider too long or
** too short to be physiologically plausible.

SELECT IF (exp < 10000).
SELECT IF (exp > 300).
SELECT IF (insp <9000).
SELECT IF (insp > 300).
EXECUTE.

COMPUTE cases_4 = $CASENUM.
VARIABLE LABLE cases_4 'Excluding non-plausible long or short breaths'.
AGGREGATE  /OUTFILE=*  MODE=ADDVARIABLES  OVERWRITE=YES /BREAK=subject /cases_4 =
MAX(cases_4).
*************************************************************************.
**With these former selection criteria the loss of data in our population was generally
** about 7%. More than 20% is considered a lot. One might want to check whether a
** lot of unreliable data is correctly rejected or whether the automatic scoring of
** AmsRes has incorrectly rejected a lot of reliable data.
*************************************************************************.
**In the remaining data, the distributions of inspiration and expiration are inspected.
** @@@@@ this has been commented out, to speed things up. A more careful, but
** less "automated" and slower, strategy would leaves this intact

** FREQUENCIES VARIABLES=insp exp/FORMAT=LIMIT (1) /PERCENTILES= 3 97 /STATISTICS=NONE
/HISTOGRAM  NORMAL.

** REMOVE OUTLIERS!! *************************************************************************.
**Usually the distribution is skewed to the right so removing with a 3 SD criterion
** eliminates about 1 to 2%
*************************************************************************.
** Add the Z-scores of inspiration and expiration time.

DESCRIPTIVES VARIABLES=insp exp /SAVE /STATISTICS=MEAN STDDEV MIN MAX .

SELECT IF Zinsp > -3 .
SELECT IF Zexp > -3 .
SELECT IF Zinsp < 3 .
SELECT IF Zexp < 3 .
EXECUTE .

COMPUTE cases_5 = $CASENUM.
VARIABLE LABLE cases_5 'Excluding breaths 3SD deviated from the mean'.
```

```
AGGREGATE  /OUTFILE=*  MODE=ADDVARIABLES  OVERWRITE=YES /BREAK=subject /cases_5 =
MAX(cases_5).
*****************************************************************************.

**With the next statements we will compute the tidal volume as the difference
** between the dZ amplitude at the peak and the troughs. The filtered signal will be
** used; note that any calibration to spirometric volumes must be done using the
** filtered volumes
*****************************************************************************.
COMPUTE Vt = dzMaxf - dzMinf.
EXECUTE.

** CHECK!! ******************************************************************************.
** Check for tidal volumes that are extremely deep or shallow.  Breaths with zero
** amplitude must always be removed There is usually a tail with very large breaths
** due to sighs. We have not removed these in previous analyses , but we
** grant this is a matter for debate.
*****************************************************************************.
** @@@@@ this has been commented out, to speed things up. A more careful, but
** less "automated" and slower, strategy would leaves this intact
**
** FREQUENCIES  VARIABLES=Vt /FORMAT=LIMIT (10) /STATISTICS=NONE /HISTOGRAM  NORMAL.

SELECT IF (Vt > 0).
*SELECT IF (Vt < 3).
EXECUTE.

COMPUTE cases_6 = $CASENUM.
VARIABLE LABLE cases_6 'Excluding zero-amplitude breaths'.
AGGREGATE  /OUTFILE=*  MODE=ADDVARIABLES  OVERWRITE=YES /BREAK=subject /cases_6 =
MAX(cases_6).
*****************************************************************************.
**With the next statements we will check for inter beat intervals that are extremely
** short or extremely long. First we temporary select longibi>0 and shortibi>0
** so values flagging missing data (-1) (i.e. breaths where no valid shoritibi
**and/or longibi could be found) are not inadvertedly included.
*****************************************************************************.
** @@@@@ this has been commented out, to speed things up. A more careful, but
** less "automated" and slower, strategy would leaves this intact
**
** TEMPORARY.
** SELECT IF longibi > 0.
** SELECT IF shortibi > 0.
** FREQUENCIES VARIABLES=shortibi longibi ibi /FORMAT=LIMIT (1)  /PERCENTILES= 5 95
/STATISTICS=NONE /HISTOGRAM NORMAL.

** CHECK!! ******************************************************************************.
**A HR lower than 35 (shortibi > 1700) is very uncommon and unlikely, although not
** impossible. The next statement excludes these beats. If these ibi's>1700 cannot be
** considered outliers (see histogram) it is recommended to check the AmsRes
** interface to see whether such beats derive from spikes or whether they are true and
** reliable. If so, disable or change the select statements below.
** In a 24 hour recordings do not be alarmed by a mixture distribution; this is what
** you expect (NIGHT vs. DAYTIME)
*****************************************************************************.
** @@@@@ THIS SET OF STATEMENTS MAY REQUIRE DIFFERENT
** PARAMETERS IN YOUR SAMPLE!!!
```

```
SELECT IF (shortibi < 1700).
SELECT IF (longibi < 1800).
EXECUTE.

COMPUTE cases_7 = $CASENUM.
VARIABLE LABLE cases_7 'Excluding very slow heart beats'.
AGGREGATE  /OUTFILE=*  MODE=ADDVARIABLES  OVERWRITE=YES /BREAK=subject /cases_7 =
MAX(cases_7).
*****************************************************************************.
** IBI's of 250 ms (HR = 240) and shorter are extremely uncommon and may very
** well be unrejected spikes. With the next statements they will be rejected. Note that
** we keep shortibi<0 and longibi<0 since these values flag the cases where no valid
** shortibi or longibi could be found within the inspirational and expirational
** intervals.
*****************************************************************************.

SELECT IF  ((shortibi > 250) OR (shortibi < 0)).
EXECUTE.
SELECT IF  ((longibi > 270) OR (longibi < 0)).
EXECUTE.
*both shortibi and longibi may not have been found.

SELECT IF  ((ibi > 260) OR (ibi < 0)).
EXECUTE.

COMPUTE cases_8 = $CASENUM.
VARIABLE LABLE cases_8 'Excluding very fast heart beats'.
AGGREGATE  /OUTFILE=*  MODE=ADDVARIABLES  OVERWRITE=YES /BREAK=subject /cases_8 =
MAX(cases_8).
*****************************************************************************.
**Here, we create a dummy variable that allows us to compute the frequency of
** breaths where RSA cannot be computed due to the absence of a valid shortibi
** and/or longibi within the respiratory cycle.
*****************************************************************************.

COMPUTE neg=0.
IF ((shortibi<0) or (longibi <0)) neg=1.
EXECUTE.
*****************************************************************************.
**The next dummy variable that is computed allows us to calculate the percentage of
** breaths where shortibi is longer than longibi (reverse=1).
*****************************************************************************.

COMPUTE reverse=0.
IF ((NEG EQ 0) AND (shortibi>longibi)) reverse=1.
EXECUTE.

FREQUENCIES VARIABLES= neg reverse /FORMAT=LIMIT(10) /STATISTICS=NONE.

** CHECK!! ******************************************************************************.
**On average, (neg=1) was about 20% in our dataset. If (neg=1) is a lot higher than
** usual in your population it might be worth to inspect the data in AmsRes to see
** whether this is due to breaths with a truly low RSA (i.e. where the
**coupling of shortibi and longibi to the respiratory cycle is lost) or whether the
** AmsRes automatic scoring program hopelessly failed for this participant
*****************************************************************************.
**RSAZERO is calculated out of shortibi and longibi. In contrast to the original RSA
** value, values for RSAZERO are set to zero when neg=1 (absence of a valid
```

```
** shortibi and/or longibi) or reverse=1 (shortibi>longibi). In our experience, a lot
**of cases of neg=1 or reverse=1 are due to a true low RSA and RSA should be set to
** zero. We also keep the original RSA value (RSA). For breaths with neg =1 or
** reverse=1, however, RSA is interpreted to be missing and these breaths are
** excluded.
*****************************************************************************.

COMPUTE rsazero = longibi - shortibi.
IF ((reverse=1) or (neg=1)) rsazero=0.
IF ((reverse=1) or (neg=1)) rsa=-1.
EXECUTE.

** This statement makes sure that missing values are excluded from the calculation of
** the means of these variables. Note that we could do this earlier than at this point
** because -1 values of longibi and shortibi were used as meaningful signals.

MISSING VALUES LONGIBI SHORTIBI RSA (-1).
EXECUTE.

** CHECK!! *****************************************************************************.
**OUTLIERS OF RR,  RSA and IBI:
**The RR, RSA and IBI histograms are visually inspected to see whether there are
** outliers. If there are outliers, it is advised to return to the AmsRes interface to
** check a couple of high RSA's to see whether these are based on reliable signal.
** In our view, the main reason for distrust of outliers would be the presence of
** unrejected spikes. In other words, in case of a good manual scoring in AmsRes,
** outliers of RSA usually are true high RSA's. If outliers of RSA are
** invalid, they can be rejected manually in AmsRes. A more time-efficient but less
** elegant method would be to exclude these outliers with a selection statement in
** SPSS instead of a manual rejection in AmsGra. In this case the selection
** statement has to be adjusted to a specific cut-off value for  each participant. This
** cut-off value can be based on a visual check of the RSA histogram
** (this is what we did 800 times) or one could exclude a set percentage for all
** subjects, for instance the highest 1%.
*****************************************************************************.
** adjust value based on the visual check of the histograms below or to the
** 99-percentile.
** @@@@@ THIS SET OF STATEMENTS MAY REQUIRE DIFFERENT
** PARAMETERS IN YOUR SAMPLE!!

*FREQUENCIES VARIABLES=rr rsa rsazero ibi /FORMAT=LIMIT (10) /PERCENTILES= 99
/STATISTICS=NONE /HISTOGRAM  NORMAL.

SELECT IF rr < 30.
SELECT IF MISSING(rsa) OR (rsa < 250).
SELECT IF rsazero < 300.
EXECUTE.

COMPUTE cases_9 = $CASENUM.
VARIABLE LABLE cases_9 'Excluding the extremes in the tail of the RR and RSA distributions'.
AGGREGATE  /OUTFILE=*  MODE=ADDVARIABLES  OVERWRITE=YES /BREAK=subject /cases_9 =
MAX(cases_9).

** CHECK!! *****************************************************************************.
** Next we correlate the RSA values with the respiration rate  C(RR, RSA) should be
** between -0.7 and -0.1, although exceptions may occur. C(RSA0, RSA) should be
** higher than 0.7
*****************************************************************************.
```

```
CORR rr rsa WITH rsazero.
EXECUTE.

**This concludes outlier detection and the selected remaining breaths can be saved**.
**SAVING RAW DATA**********************************************************.
** What we are SAVING here is a set of variables that have a value for each
** BREATH, i.e. each BREATH is treated as a single case by SPSS.
** All _amsres.sav files can be added in an additional job to make one final RSA
** datafile including all your subjects.
*****************************************************************************.

SAVE OUTFILE=!DIRY+!FILE+'_amsres'+'.sav'.
EXECUTE.

** CHECK!! ******************************************************************.
** Be aware of how much signal you throw away and why. In our dataset, about 11%
** of the data was thrown away on average. About ten percent was rejected through
** the AmsRes automatic scoring program and manual rejection. The SPSS outlier
** detection job was responsible for an additional 1%. However the percentage of
** breaths that need to be rejected varies between subjects. In participants with a lot
** of bad signal for example (spikes, clipping, abdominal breathing) this could go up
** to 40%. But: better safe than sorry: Only parts of the signal that show no evidence
** of artifacts should be saved. Do not worry about removing a couple of breaths too
** many when dealing with  a 24hr ambulatory monitoring signal. Clearly, this
** nonchalance is only  justified when rejected data is spread randomly
** throughout the signal. When bad signals always occur at certain emotions or events,
** it would be a changing in the data to systematically remove these breaths.
*****************************************************************************.

COMPUTE dataloss= ((cases_1 - cases_9)/cases_1)*100.
EXECUTE.
VARIABLE LABEL dataloss 'Percent of breaths that were lost due to artifact and outlier rejection'.

DESC /VAR cases_1 cases_2 cases_3 cases_4 cases_5 cases_6 cases_7 cases_8 cases_9 dataloss /STAT
=MEAN.

** AGGREGATING DATA ACROSS CATEGORIES
*****************************************************************************.
** Usually, the analyses will need a data set that is aggregated across longer time
** periods with fixed values for the labeling categories. This is done by the SPSS
** AGGREGATE COMMAND
** @@@@@ The AGGREGATE COMMAND below assumes that you used the
** following five CATEGORIES for labeling with AMSGRA;
** posture= a code stating the dominant posture during that period (10 levels)
** physical load      = a code indicating the level of physical load (6 levels)
** activity= type of activity the subject is engaged in (24 levels)
** location           = a code for the location of the subject (9 levels)
** social situation = indicating the social situation the subject is in (8 levels)
** This is unlikely to correspond to your own categories. Change the command syntax
** accordingly, i.e. change
**
**     /BREAK= subject posture physical activity location social
**
** to the appropriate description of the categories you used to label the data
*****************************************************************************.
GET FILE=!DIRY+!FILE+'_res'+'.sav'.
```

```
AGGREGATE
  /OUTFILE=*
  /BREAK= subject posture physical activity location social
  /strtdate = MIN(date)
  /enddate = MAX(date)
  /strttime = MIN(time)
  /endtime = MAX(time)
  /mrsa = MEAN(rsa)
  /mrsa0 = MEAN(rsazero)
  /mibi = MEAN(ibi)
  /mrr = MEAN(rr)
  /mvt = MEAN(Vt)
  /sdrsa = SD(rsa)
  /sdrsa0 = SD(rsazero)
  /sdibi = SD(ibi)
  /sdrr = SD(rr)
  /sdvt = SD(Vt).

*****ADD VARIABLE LABELS*********************************************.
VARIABLE LABEL strtdate 'start date of the labeled period in dd:mm:yy'.
VARIABLE LABEL enddate      'end date of the labeled period in dd:mm:yy'.
VARIABLE LABEL strttime     'start time of the labeled period in hh:mm:ss'.
VARIABLE LABEL endtime      'end time of the labeled period in hh:mm:ss'.
VARIABLE LABEL mrsa         'aggregated RSA (ms) across all breaths in the label (not including zero)'.
VARIABLE LABEL mrsa0        ' aggregated RSA (ms) across all breaths in the label (including zero)'.
VARIABLE LABEL mibi         'aggregated IBI across all breaths in the  label (ms)'.
VARIABLE LABEL mrr          'aggregated RR across all breaths in the label (breaths per minute)'.
VARIABLE LABEL mvt          'aggregated Vt across all breaths in  the label (arbitrary units)'.
VARIABLE LABEL sdrsa        'SD of RSA across all breaths in the label (RSA not including zeros)'.
VARIABLE LABEL sdrsa0       'SD of RSA across all breaths in the label (RSA including zeros)'.
VARIABLE LABEL sdibi        'SD of IBI across all breaths in the label'.
VARIABLE LABEL sdrr         'SD of RR across all breaths in the label'.
VARIABLE LABEL sdvt         'SD of Vt across all breaths in the label'.
EXECUTE.

** VALUE AND VARIABLE LABELING ***************************************************************************.
** Use an INCLUDE FILE to supply the correct variable and value labels for (all of)
** the numerical codes used when labeling the AMS-file with AMSGRA. Note that
** the file name needs to be changed to the name of your study specific include file
** that you prepared before running this job.
** In the example below the include file supplies VARIABLE names and VALUES
** for posture, physical load, type of the activity, location and social situation.
** This may, of course, be different in  your include file.
*********************************************************************************.
INCLUDE !DIRY+!labelF+'.sps'.

**SAVING DATA*************************************************************.
** What we are finally SAVING is a set of variables that have a value for each labeled
** period. Each labeled period is treated as a single case by SPSS. Although the code
** of the subject is available for each labeled period, an SPSS "case"
** now does NOT equal a "case" (subject) in your study!
*********************************************************************************.

SAVE OUTFILE=!DIRY+!FILE+'_amsres.sav'.
EXECUTE.
```

CHECK_AMSIMP_Your_subject_1.sps

```
SET PRINTBACK = OFF.

** File name = CHECK&_AMSIMP_singlesubject_generic.sps.
** Version July 2007.
** label Data File version 101.
** Some easy to locate DEFINEs that set the WORKING DIRECTORY, the
** input file with the large scale ensemble averaged impedance data (.iar) for a single
** subject and a file that defines the variable and value labels for the categories of your
** labeled periods. We also define the electrode distance between the measurement
** electrodes for this specific individual (default = 20).

DEFINE   !WD()       'C:\Your_full_directory_tree\'          !ENDDEFINE.
DEFINE   !FILE()     'Your_file_for_subject_1'               !ENDDEFINE.
DEFINE   !Electrode_distance 20                                      !ENDDEFINE
DEFINE   !LABELF()  'label_VAR&VALUES_your_project'      !ENDDEFINE.

***ATTENTION*****************************************************************.
** Although this job is fairly generic, it may need some adjustments to  fit your data.
** Search for the sections labeled with '@@@@@@' to bring this job in accordance
** with the protocol of your specific study and your own wishes regarding
** data handling (what to save and what not).
*******************************************************************************.
**SCRIPT HISTORY**************************************************************.
** Eco de Geus Version 13-02-1996
** Adjusted for A'dam Work Stress studies: Tanja Vrijkotte & Harriette Riese 1997
** Adjusted for NETAMB: Nina Kupper 2004
** SV parameter computation added Annebet Goedhart 2005
** Lay-out & Logic update Eco de Geus & Annebet Goedhart July 2007
*******************************************************************************.
**GENERAL DESCRIPTION*********************************************************.
** This is an SPSS syntax script for SPSS for windows version 13 or higher.
** INPUT: The script will read an individual .iar file delivered by AMSIMP using the
** DATA LIST command below. It is assumed that each line of the .iar file represents
** ICG data from the large scale ensemble average across an entire labeled period.
** When saving the .iar file make sure to create an average report file (iar) with option
** "average over labels" checked also make sure that UNLABELED PERIODS are
** NOT WRITTEN to the outputfile by AMSIMP (uncheck option "write unlabeled
** periods")
** Stroke volume based parameters are meaningful only if Z0 and L have been
** appropriately filled in for the subject.
** ACTION: The AMSIMP data are read into SPSS. Integrity of the impedance data
** is checked in various ways and a number of additional parameters are computed.
** LIST OF VARIABLES TO BE READ:
** Subject = Subject identification (1-8 string)
** ensemble_no      = Number of the ensemble average since start of recording,
** starts at 0 (9-15 integer)
** block = Beat to beat block number, starts at 0... can still be > 1 in
** continuous recordings because of hold continues (16-22 integer)
** date = Start date of the ensemble average (24-31 date dd-mm-yy)
** time     = Exact start time of the ensemble average (33-40 time hh:mm:ss)
** PEP      = Time of the upstroke (B-point), this time is in reference to Q-ONSET
** in ms (41-46 integer)
** dzdt_min          = Time of the dz/dt-min point (Z-point), this time is in reference
** to Q-ONSET in ms (47-52 integer)
** incis     = Time of the incisura (X-point), this time is in reference to Q-ONSET
** in ms (53-58 integer)
```

```
** Zo = Average thorax impedance (Ohm) during the entire ensembling
** period (59-65 float)
** ibi = Average R-wave to R-wave interval in ms (66 - 71 integer)
** amp_upstroke = Amplitude of dZ/dt signal at the B-point from x-axis in
** Ohm/s (72 - 77 float)
** amp_dzdtmin = Amplitude of dZ/dt-min point from x-axis in Ohm/s
** (78 - 83 float)
** amp_inci = Amplitude of dZ/dt signal at the incisura in Ohm/s (84 - 89 float)
** LVET = Left ventricular ejection time in ms (90 - 95 integer)
** Rw_dz = R-peak to dz/dt min interval in ms (96 - 101 integer)
** SV = Stroke volume in cc (102 - 109 float)
** Whether this is in relation to signal amplitude at dZ/dt=0 or at the B-point
** depends on what option was checked in AMSIMP!
** heather = Heather Index in ohm/s^2 (110 - 117 float)
** accep = During visual scoring you interactively set this variable to A=accepted,
** R=REJECTED or C=CORRECTED (119 char)
** Optional descriptions of the period (N/A if not available) columns 120+
**   label# = labeled period number (starting at 1, 0 if N/A)
**   postu = a code describing the predominant posture during that period
**   physic = a code describing the predominant physical load during that period
**   activ = an activity code categorizing possible daily activities of the study group
**   locat = code describing the main location during that period
**   socia = code describing the main social situation during that period
**   stress = code describing subjective stress during that period
**   These final 6 categories are labels specification, which you can change at will when
** you have used other labels to label the AMSgra file.
**
** NOTA BENE: Time of Q-ONSET is imputed by AMSIMP by subtracting 48
** ms from the time of the R-wave onset
**
** ADDITIONAL PARAMETERS COMPUTED:
** We compute Stroke Volume by the Kubicek formula
** Kubicek (1966) SVkubi = rho * ( (L*L)/(Z0*Z0) ) * (dZ/dt)max * LVET
** rho = 135 ohm/s.
** L defined above
** Z0 = average thorax impedance in the ensemble average
** Cardiac output is computed as SV * Heart rate
** SVb follows the official stroke volume computation. It should correspond to what
** AMSIMP has computed if the electrode distance had been filled out correctly.
** If L had not been filled out properly it can in principle be computed from the
** difference between the computed SVb and the original AMSIMP SV.
** As an alternative stroke volume measure SV can also be computed as SV0.
** In this computation the B point is measured in relation to the dZ/dt=0 baseline.
** We have not implemented this formula in the syntax.
** For further information see Goedhart et al., 2006 (Biol Psych 72:110-17).
** We also compute the Heather index by the Kelsey formula.
** Kelsey proposed to scale the dZ/dt min amplitude to total Z before computing the
** HI.
** Heather_kelsey=(SVb_ampl/Z0)/dzdt_min.
** SVb_ampl = dZ/dt amplitude from B-point to dz/dt-min peak
** Z0 = average thorax impedance in the ensemble average
** dZ/dt_min = time of the dz/dt-min point in reference to Q-ONSET

** OUTPUT: The resulting .SAV file will consider each labeled period to be a "case".
** Therefore, per subject there will be a PEP, SV etc for each labeled period.
*********************************************************************.
** @@@@@@ FILE AND DIRECTORY STRUCTURE**********************.
** WE ASSUME THAT FILE NAMES ARE EXACTLY 7 CHARACTERS LONG
```

```
** & REFLECT THE ID OF THE SUBJECT NOTE THAT THE FILENAMES
** USED IN DATA LIST AND SAVE OUTFILE COMMANDS MUST BE
** CHANGED TO CORRESPOND TO YOUR OWN FILENAMES AND
** DIRECTORY STRUCTURE. THIS CAN BE DONE BY CHANGING THE
** DEFINE STATEMENTS AT THE START OF THIS JOB
*****************************************************************************.
** @@@@@@ PROJECT SPECIFIC LABELING**************************.
** The job text below assume that you used the following categories to label the data:
** posture= a code stating the dominant posture during that period (10 levels)
** physical load      = a code indicating the level of physical load (6 levels)
** activity           = type of activity the subject is engaged in (24 levels)
** location           = a code for the location of the subject (9 levels)
** social situation   = indicating the social situation the subject is in (8 levels)
** This is unlikely to correspond to your own categories. Change the command syntax
** accordingly, i.e. change
**          posture 124-128(F) physical 129-132(F) activity 133-136(F)
**          location 137-140(F) social 141-144(F)
** to the appropriate description of the categories you used to label the data.
*****************************************************************************.
***WARNING FOR POTENTIAL PROBLEMS
*****************************************************************************.
** The largest problem that arises during the GET DATA statement is that the input
** has a comma-notation for floating point notation (e.g. 8,03) whereas SPSS expects
** a dot-notation (8.03) or vice versa. When the need arises: In the control panel of
** Windows select 'regional and language options' / 'customize' and set the decimal
** symbol for numbers to 'dot'.
*****************************************************************************.
***** READING AN INDIVIDUAL IAR-FILE ******************************.
TITLE 'PROCESSING VU-AMS IAR-FILES CREATED WITH AMSIMP'.

DATA LIST FILE= !WD + !FILE + '.iar'
  fixed records=1 /1  subject 1-8(F) ensemble_no 9-15(F) block#  16-22(F) strtdate 24-31(edate)
strttime 33-40(time) PEP 41-46(F) dZdt_min 47-52(F) incisura 53-58(F) Z0 59-65(2) IBI 66-71(F)
amp_upstroke 72-77(F) amp_dzdtmin 78-83(F) amp_inci 84-89(F) LVET 90-95(F) Rw_dZdT 96-101(F) SV
102-109(F) heather 110-117(F) Accepted  119(A) label# 120-123(F) posture 124-128(F) physical 129-
132(F) activity 133-136(F) location 137-140(F) social 141-144(F).
EXECUTE.

FORMATS pep TO heather (F8.2).

** An error in your output file indicating that the string 'N/A ' cannot be read in the
** 'labelno' field, indicates that you have included the non labeled ICG complexes in
** your *.iar file. Fix this (one of the options in the AMSIMP menu).
*****************************************************************************.
*****ADD VARIABLE LABELS**********************************************.
VARIABLE LABEL strtdate 'Start date of the ensemble average (dd-mm-yy)'.
VARIABLE LABEL strttime 'Start time of the ensemble average (hh:mm:ss)'.
VARIABLE LABEL ensemble_no 'Number of the ensemble average since start of recording, starts at 0'.
VARIABLE LABEL block#  'Beat to beat block number'.
VARIABLE LABEL label#  'Sequential label number'.
VARIABLE LABEL PEP 'PEP:Time of the upstroke (B-point) in reference to Q-ONSET (ms)'.
VARIABLE LABEL dzdt_min 'time of the dz/dt-min point in reference to Q-ONSET (ms)'.
VARIABLE LABEL incisura 'time of the incisura (X-point) in reference to Q-ONSET (ms)'.
VARIABLE LABEL Z0 'Average thorax impedance (Ohm)'.
VARIABLE LABEL IBI 'average R-wave to R-wave interval (ms)'.
VARIABLE LABEL amp_upstroke ' Amplitude of dZ/dt signal at the B-point from x-axis in Ohm/s'.
VARIABLE LABEL amp_dzdtmin 'Amplitude of dZ/dt-min point from x-axis in Ohm/s'.
VARIABLE LABEL amp_inci 'Amplitude of dZ/dt signal at the incisura in Ohm/s'.
```

```
VARIABLE LABEL LVET 'LVET: Left ventricular ejection time in ms'.
VARIABLE LABEL Rw_dzdt 'R-peak to dz/dt min interval in ms'.
VARIABLE LABEL SV 'Stroke volume in cc'.
VARIABLE LABEL heather 'Heather Index in ohm/s^2'.
VARIABLE LABEL Accepted 'During visual scoring you interactively set this variable to A=accepted,
R=REJECTED or C=CORRECTED'.
EXECUTE.
*****************************************************************************.
 ** VALUE AND VARIABLE LABELING ***********************************************************************************.
** Use an INCLUDE FILE to supply the correct variable and value labels for (all of)
** the numerical codes used when labeling the AMS-file with AMSGRA. Note that
** the file name needs to be changed to the name of your study specific include file
** that you prepared before running this job.
** In the example below the include file supplies VARIABLE names and VALUES
** for posture, physical load, type of the activity, location and social situation. This
** may, of course, be different in your include file.
*****************************************************************************.
INCLUDE !WD + !LABELF+'.sps'.

**REMOVING REJECTED DATA ***************************************************************************.
** Remove data that was rejected during interactive visual scoring

SELECT IF accepted NE 'R'.
EXECUTE.
*****************************************************************************.
**CALCULATIONS SECTION*****************************************.
** We compute Stroke Volume by the Kubicek formula
** Kubicek (1966) SVkubi = rho * ( (L*L)/(Z0*Z0) ) * (dZ/dt)max * LVET
** rho = 135 ohm/s.
** L defined above
** Z0 = average thorax impedance in the ensemble average
** Cardiac output is computed as SV * Heart rate
** SVb follows the official stroke volume computation. It will differ from the SV
** computed by AMSIMP for one or two of the reasons below:
** - AMSIMP uses the amplitude of dZ/dt_min in relation to the zero-amplitude at
** the dZ/dt baseline instead of the amplitude at the B-point.
** - The electrode distance L may not yet have been entered properly during
** AMSIMP scoring
** As an alternative stroke volume measure SV can also be computed as SV0.
** In this computation the B point is scored in relation to the dZ/dt=0 baseline.
** We have not implemented this formula in the syntax.
** For further information see Goedhart et al., 2006 (Biol Psych 72: 110-117).
** We also compute the Heather index by the Kelsey formula.
** Kelsey proposed to scale the dZ/dt_min amplitude to total Z before computing
** the HI.
** Heather_kelsey=(SVb_amp/Z0)/dzdt_min.
** SVb_amp = dZ/dt amplitude from B-point to dz/dt_min peak
** Z0 = average thorax impedance in the ensemble average
** dZ/dt_min = time of the dz/dt_min point in reference to Q-ONSET.
*****************************************************************************.
COMPUTE L = !electrode_distance.
COMPUTE SVb_ampl = amp_dzdtmin - amp_upstroke.
COMPUTE SVbamp_x_lvet = SVb_ampl * (lvet/1000).
COMPUTE L02Z02 = ( (L*L)  / ( Z0 * Z0 ) ).
EXECUTE.
COMPUTE SVb =  -135 * L02Z02 * SVbamp_x_lvet.
EXECUTE.
COMPUTE HR = 60000/IBI.
```

```
COMPUTE CO  =   (SV   * HR) /1000.
COMPUTE COb =  (SVb * HR) /1000.
EXECUTE.

** Kelsey proposed to scale the dZ/dt min amplitude to total Z before computing the
** HI.
COMPUTE Heather_kelsey=(SVb_ampl/Z0)/dzdt_min.
EXECUTE.

VARIABLE LABEL SV 'Stroke volume (from B-point) in cc (correct if L was filled out during AMSIMP
scoring)'.
VARIABLE LABEL SVb 'Stroke volume (from B-point) in cc (correct if L was defined in the SPSS job)' .
VARIABLE LABEL HR  'Heart rate in bpm'.
VARIABLE LABEL CO 'Cardiac Output (from B-point) in liters'.
VARIABLE LABEL COb 'Cardiac Output (from B-point) in liters'.
VARIABLE LABEL L02Z02 'Electrode distance squared divided by resting impedance squared'.
VARIABLE LABEL SVb_ampl 'dZ/dt amplitude from B-point to dz/dt-min peak'.
VARIABLE LABEL SVbamp_x_lvet 'product dZ/dt amplitude from B-point en LVET'.
VARIABLE LABEL L 'distance between the front electrodes (cm)'.
VARIABLE LABEL Heather_kelsey 'Alternative heather index according to Kelsey (arb units)'.
EXECUTE.

**OUTLIER DETECTION**************************************************.
** Check whether your physiological variables remain within their plausible
** physiological range, for example by looking at histograms.
** This is a topic that is subject to personal opinion, you must ultimately decide how
** to deal with outliers yourself. A first rough selection of possible outliers can be
** based on physiologically implausible values that are outside these ranges:
** Plausible physiological range:
** DZDTMIN          dZdt-min amplitude          -2.5 -   -0.15 Ohm/s
** PEP              Pre-ejection period         50   -  170    ms
** LVET             Left ventricular ejection   150   -  500    ms
** HR               Heart rate                  30   -  180    bpm
** IBI              Inter beat interval         333   - 2000    ms
** ZO               Average thorax impedance    6   -   17    Ohm
** STROKE           Stroke volume               40 -  200      cc
** CO               Cardiac Output              3 -   35      l
** HI               Heather index              -40 -    0      Ohm
******************************************************************************.
EXAMINE VARIABLES=ibi pep lvet SV SVb /PLOT  HISTOGRAM  /STATISTICS NONE /MISSING LISTWISE
/NOTOTAL.

** Generic exclusion criteria
COMPUTE exclude = 0.
IF (HR< 30) OR (HR > 200) exclude = 1.
IF (Z0 < 6) OR (Z0 > 17) exclude = exclude + 10.
IF (PEP < 50) OR (PEP > 170) exclude =exclude + 20.
IF (LVET < 150 ) OR (LVET > 450) exclude = exclude + 30.
EXECUTE.

SELECT IF (exclude eq 0).
EXECUTE.
** Project specific exclusion criteria.
** @@@@@ (FILL IN AS REQUIRED)
EXECUTE.

** How many labels were excluded and for what reason?.
FREQ exclude.
```

```
**DETECTION OF POTENTIAL INCONSISTENCIES IN INTERACTIVE
** SCORING ************************************************************.
** Please check the correlations and the graphs carefully. If an outlier can be
** identified, go back to AMSIMP, to decide whether you are convinced the B
** or X point should be where you put it.
** CHANGE THINGS ONLY IF YOU REALLY MADE AN OBVIOUS
** MISTAKE!
** The correlation between PEP and SV will mostly be positive (0.2-0.6)
** The correlations of PEP with IBI (0.2-0.5) and LVET with IBI (0.3-0.7) will also be
** generally positive.
** For PEP these rules do not always work, a failure to find lvet-ibi correlations is
** more alarming.
** If the graph shows a clear outlier in either PEP or LVET it is almost always your
** scoring that caused it, and not physiology. Go back to the AMSIMP file for closer
** inspection.
** If you have doubts about this scoring, don't hesitate to ask for another (our?)
** opinion. If you're sure about your scoring, ALWAYS let ICG morphology prevail
** over 'desirable correlations between PEP and IBI and PEP and LVET'.
*************************************************************************.
CORR /VAR PEP LVET with IBI SV Heather.

GRAPH /SCATTERPLOT(BIVAR)=SV WITH pep /MISSING=LISTWISE .

GRAPH /SCATTERPLOT(BIVAR)=ibi WITH pep  /MISSING=LISTWISE .
GRAPH /SCATTERPLOT(BIVAR)=ibi WITH lvet  /MISSING=LISTWISE .

*************************************************************************.
**SAVING DATA*********************************************************.
** We happily throw away redundant or unimportant information at this point.
** Save your icg outfile now. All _amsimp.sav files can be added in an additional job
** to make one final ICG datafile including all your subjects.
*************************************************************************.

SAVE OUTFILE= !WD + !FILE + '_amsimp.sav'
/KEEP subject ensemble_no strtdate strttime Z0 L PEP LVET IBI Heather Heather_kelsey SV SVb HR CO
COb label# posture physical activity location social.
```

List of publications

Papers

Goedhart AD, Kupper N, Willemsen G, Boomsma DI, de Geus EJC (2006). Temporal stability of ambulatory stroke volume and cardiac output measured by impedance cardiography. *Biological Psychology* 72, 110-117.

Goedhart AD, van der Sluis S, Houtveen JH, Willemsen G, de Geus EJC (2007). Comparison of time and frequency domain measures of RSA in ambulatory recordings. *Psychophysiology* 44(2), 203-215.

Goedhart AD, Bakker F, de Vries M, Kreft J, de Geus EJC (revision submitted). No effects of two weeks of detraining on ambulatory measures of cardiac autonomic control. *Journal of Psychophysiology*.

Goedhart AD, Willemsen G, Hoogendijk WJG, van Weissenbruch MM, de Geus EJC (submitted). No evidence for permissive effects of the early morning cortisol rise on daytime sympathetic and cardiovascular reactivity to stress. *Biological Psychology*.

Goedhart AD, Houtveen JH, de Geus EJC (accepted). Comparing low frequency heart rate variability and pre-ejection period: two sides of a different coin. *Psychophysiology*.

Book chapter

Goedhart AD, Willemsen G, de Geus EJC (2008). Sympathetic nervous system activity in the heart and the skin: are they comparable? In Kaneko M (Ed): *Sympathetic Nervous System Research Developments*. New York: Nova Science publishers.

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